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Cost-effective design of agri-environmental payment programs: U.S. experience in theory and practice

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ABSTRACT

Key features of U.S. agri-environmental programs are reviewed and analyzed using literature review and program data. We focus, in particular, on several key questions: Has benefit–cost targeting increased the environmental benefit obtained from program budgets? Has competitive bidding reduced program costs? To what extent have these program designs resulted in additional gain (that would not have otherwise been obtained)? Previous research illustrates how benefit–cost targeting using environmental indices (such as the Environmental Benefits Index in the Conservation Reserve Program) can increase environmental cost-effectiveness. Previous research and data from two U.S. programs suggests that bidding has reduced costs, but that the full potential of bidding may not have been realized. Finally, most U.S. programs are intended to yield environmental gains that would not have otherwise been obtained, but sometimes fall short of this goal.

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1. Introduction and background

The United States has a long history of providing payments for environmental services. Prompted by drought, dust storms, and economic depression, the U.S. began assisting farmers with soil conservation in the 1930s. Since then, the U.S. government has relied primarily on voluntary payment programs to encourage soil conservation and other improvements in agri-environmental performance, although cross-compliance and regulation have also been used.

Land retirement, in particular, has been a mainstay of U.S. agri-environmental policy. In general, these programs have retired land from crop production for the purposes of improving crop prices, protecting the soil, and, since the early 1990s, reducing environmental damage from agricultural production.

For much of the past 70 years, episodes of land retirement have followed severe downturns in crop prices (Heimlich and Claassen, 1999). Between 1936 and 1942 – in the latter part of the great depression – payments authorized by the Agricultural Adjustment Act of 1936 prompted retirement of as much as 40 million acres (16.2 million hectares)[2] per year (Berg and Grey, 1984; Crosswhite and Sandretto, 1991). The Soil Bank (1956–1972) also began in the wake of a sharp decline in crop prices. Finally, the Conservation Reserve Program (CRP) – the third major wave of land retirement – began in 1985 in the midst of a deep recession in the U.S. farm economy. While the original CRP focused on enrolling land quickly (Reichelderfer and Boggess, 1988), the program has evolved into a multi-objective program that produces environmental benefits beyond the traditional concern for soil erosion and productivity (Feather et al., 1999).

Alongside the large sums of money that were periodically devoted to large-scale land retirement, the Federal government also devoted smaller sums to improving agri-environmental performance on working agricultural land (e.g., cropland and

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[2] One acres equals .4046 ha.

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grazing land). Beginning in 1936, the Agricultural Conservation Program (ACP) provided cost-sharing for the construction of terraces, grassed waterways, and other soil conservation structures. More recently, ACP funded a broader range of agri-environmental activities, including the installation of livestock waste handling facilities. In 1996, ACP was combined with a number of smaller programs to form the Environmental Quality Incentives Program (EQIP). Like CRP, EQIP has multiple environmental objectives extending well beyond soil erosion.

The United States has also utilized regulatory instruments to pursue environmental objectives. In the 1970s, U.S. lawmakers enacted a series of broad, cross-industry environmental laws, e.g., the Clean Air Act (CAA) and the Clean Water Act (CWA). Under these laws, the newly established Environmental Protection Agency (EPA) published regulations which effectively mandated the use of specific technologies in many industries. In agriculture, CWA authority is used (since 2003) to regulate waste handling and disposal by large confined animal feeding operations (CAFOs). Other examples of regulation influencing the environmental performance of U. S. farms include the Federal Insecticide, Fungicide, and Rodenticide Act (1972), which banned a number of widely used agricultural pesticides, and the Endangered Species Act (1973), which has potentially significant impacts for land use and land management in agriculture because of its focus on maintaining critical habitat (Goldstein, 1996).

In 1985, the U.S. initiated the use of environmental cross-compliance in agricultural programs. Cross-compliance makes eligibility for income support and other programs subject to compliance with some environmental standard or requirement. In the U.S., eligibility for a broad range of agricultural programs is contingent on (1) applying an approved soil conservation plan on highly erodible cropland and (2) refraining from draining wetlands for agricultural production. Although not technically a regulation, cross-compliance can be considered an involuntary program, which has characteristics of both taxes and regulation (Heimlich and Claassen, 1998).

2. Design of U.S. agri-environmental payment programs: Broad considerations

U.S. agri-environmental programs involve cash payments from the government to producers in exchange for altering land use or adopting practices designed to help meet environmental objectives on land in production. These programs are funded from general revenues. So, while the public at large is both the "buyer" and "recipient" of the environmental services generated by these programs, there is no attempt to ensure that *individuals* who benefit from the programs also pay for them.

Many U.S. agri-environmental payment programs have multiple objectives. These programs are typically implemented using environmental indices to rank contracts (offered by farmers) in terms of environmental gain and cost. The relative importance of each environmental objective is expressed as its relative weight within the index. At present, the U.S. focuses heavily on water quality (surface and ground), wildlife habitat, and soil quality (preserving soil productivity), with lesser focus on air quality, carbon sequestration, and energy conservation.

Of course, program funds are not always directed solely on the basis of stated environmental objectives. As alluded to above, land retirement programs have always had supply management objectives. Heavy reliance on voluntary payment programs in agri-environmental policy also indicates a concern for the economic welfare of farmers. Furthermore, equity among producers is often an issue. For example, the distribution of agri-environmental funds among states has emerged as an issue in recent years. Special preferences for limited resource (poor) farmers are included in EQIP.[3] Others have argued, as a matter of equity, that "good actors" – producers who have reached a high level of environmental performance without government assistance – should be eligible for agri-environmental payments, even if these payments do not produce additional environmental gain (Claassen et al., 2001). In other cases, U.S. agri-environmental programs seek to offset the cost of environmental regulation (see discussion of EQIP, below).

Once objectives are defined, whatever they are, maximizing the extent to which these objectives can be achieved entails designing programs to be cost-effective. Environmental cost-effectiveness has been an important criterion in the development of U.S. agri-environmental policy since the early 1990s. In 1990, the U.S. Congress authorized environmental benefit–cost targeting in CRP (Osborn, 1993) and in 1996, Congress directed USDA to maximize environmental benefits per dollar of program expenditure in implementing EQIP (U.S. Congress, 1996).[4] Maximizing benefits per dollar of expenditure implies (1) targeting payments to those combinations of specific practices and tracts of land that yield the greatest environmental benefit per dollar of cost, and (2) making payments in amounts that equal the minimum necessary to encourage producers to adopt the desired practices on the targeted tracts of land, as additional payments would dissipate resources that could be spent on leveraging additional environmental gain.

[3] A Limited resource farmer or rancher has (a) direct or indirect gross farm sales of not more than $100,000 in each of the previous two years and (b) total household income at or below the national poverty level for a family of four, OR less than 50% of county median household income in each of the previous two years.

[4] These legislative directives are not exactly aligned with the standard definition of cost-effectiveness: achieving an environmental goal at the lowest possible cost to society (Baumol and Oates). A key difference involves the role of transfer payments. In this context, a transfer is made when a payment exceeds the producer's cost of participation. Economic cost is the cost of actually adopting conservation practices including technical assistance and transaction costs. In the standard formulation, transfer payments cancel out of the social welfare calculation, except for deadweight losses due to taxation, estimated to be 20–50% in the U.S. (Browning, 1987). When program expenditure is limited by a budget, however, transfer payments use up program budget that could be spent on additional conservation effort. Thus, the budget constrained formulation of the cost-effectiveness criterion (maximize environmental gain given the available budget) is not a mirror image of the standard cost-effectiveness criterion. Maximizing environmental gain subject to a budget constraint implies minimization of both economic costs (as in the most standard cost-effectiveness criterion) *and* transfer payments. As a result, budget-constrained cost-effectiveness may be more difficult to achieve than standard cost effectiveness.

To do this, program managers would have to be able to identify those combinations of land and practices that would yield the greatest environmental benefit relative to cost. Therefore, understanding the relationship between environmental benefits and costs is critical in establishing cost-effective agri-environmental programs (Babcock et al., 1997; Wu et al., 2001). For land retirement, the relationship between the productivity and environmental sensitivity of land is critical. If low productivity land – which is inexpensive to retire – is also environmentally sensitive (i.e., costs and benefits of land retirement are negatively correlated) or the benefits of land retirement vary only slightly relative to cost, enrolling producers on the basis of low cost approximates benefit–cost targeting. However, the relationship between productivity and environmental benefits is not so straightforward. Environmental benefits and land retirement costs may be negatively correlated, positively correlated, or essentially un-correlated (see Heimlich, 1989; Babcock et al., 1996).

Understanding the relationship between costs and benefits is also critical to the development of cost-effective programs for working land. Heterogeneity of land has been identified as a key issue in determining both the environmental benefits and costs of adopting environmentally sound practices. Caswell and Zilberman (1986) show that land quality is a key factor in producer adoption of irrigation technologies that can reduce water consumption. Khanna et al. (2002) adapt the Caswell–Zilberman model to study input use and technology adoption in response to various policy instruments when land is heterogeneous. Lichtenberg (1989) shows that soil quality is a key factor in determining which land was developed for irrigation in the high plains following the introduction of center-pivot irrigators. Cattaneo et al. (2005) show that environmental benefits and the cost of practices commonly used to obtain these benefits on working lands can be negatively correlated, positively correlated, or essentially uncorrelated.

Other studies show how differences in education, experience, primary occupation (farm or non-farm), and other socioeconomic characteristics – as well as land characteristics – can be important in the adoption of various conservation practices (e.g., Caswell et al., 2001; Cooper and Keim, 1996; Soule et al., 2000; Khanna, 2001; Lichtenberg, 2004). Risk preferences may also play a role in adoption of conservation practices. Land retirement is widely viewed as risk reducing by replacing uncertain income from crop production with certain income from annual payments, lowering the level of incentives necessary for retirement (Latacz-Lohmann and Van der Hamsvoot, 1997). On working land, however, some practices, including conservation tillage and nutrient management may be viewed as risk increasing, which may increase the incentives needed to encourage adoption of these practices (see Sandretto, 1997; Sheriff, 2005; Isik and Khanna, 2003).

3. Design of U.S. agri-environmental payment programs: Gathering and using information

The foregoing suggests that implementing a (relatively) cost-effective agri-environmental program requires a great deal of information on potential environmental benefits and the minimum level of payment producers would be willing to accept (WTA) for taking actions to achieve these benefits. Because environmental benefits and producer WTA can vary widely, selecting environmentally cost-effective combinations of land and practices could require assessment of potential benefits and knowledge of producer WTA for millions of combinations. While a detailed, national assessment of all these combinations would not be possible, policymakers can harness competition to gather information helpful in estimating potential environmental benefits and costs. Because all current USDA programs are budget or acreage limited, program enrollment is competitive. Through competitive bidding, policy makers can learn what land producers are willing to offer for program enrollment, which practices they are willing to adopt, and what level of payment they are willing to accept.

In essence, the U.S. strategy for obtaining (relatively) cost-effective outcomes involves (1) gathering information as part of program applications and (2) using benefit–cost indices to select program participants from a larger pool of applicants. Program application and enrollment can be thought of as a winnowing process, starting with all farmers and ranchers and eventually settling on a group of program participants (Fig. 1). Eligibility determines which producers can apply, while participation incentives (payment levels) determine which producers are interested in participating. Benefit–cost criteria can be used to select program participants from the pool of available applicants.

U.S. agri-environmental programs are offered in the form of a request for proposals from producers. The government's request generally indicates who can submit proposals (i.e., who is eligible), minimum requirements in terms of conservation action, how much producers can expect to be paid (or, for some programs, the maximum bid that could be accepted), and information on the criteria by which proposals will be assessed. In programs where producers bid on financial assistance, USDA generally establishes bid limits that deter some producers from applying. Information on bid assessment may encourage some producers, who see their chances of acceptance as high, to apply for the program while others, who believe their chances are poor, may be deterred.

Producers who are interested in participating respond with bids. Bids indicate what land will be enrolled, what practices will be installed or adopted, and may indicate the producer's desired payment. In some programs, producers have broad latitude to propose a conservation plan that addresses specific environmental concerns but also fits into their overall farming or ranching operation.[5] Producers may also be asked to bid on financial assistance. Alternately, payment rates may be fixed on a per-acre basis or a fixed percentage of practice installation cost.

Once bids are submitted, information on the location of the tract and practices to be applied can be linked to data on soils, local population, and other factors that could be used to help assess potential benefits. Producer bids on financial assistance, when they are used, establish contract costs (to the government). Even when producers are not asked to bid, information on location and practices can help USDA assess potential contract costs.

[5] Assistance with conservation planning is available to producers from USDA.

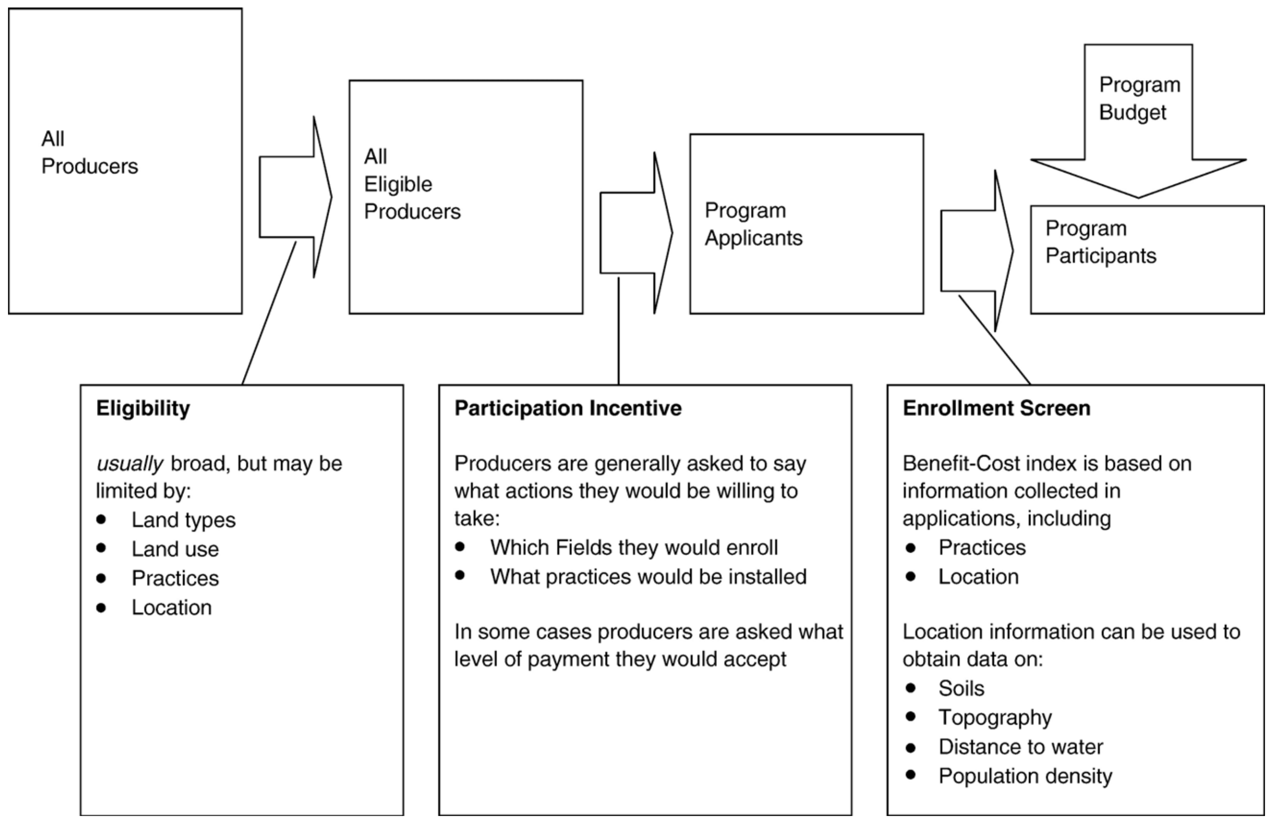


Fig. 1 – Program features determine agri-environmental program enrollment.

Using this and other information, producer applications can be ranked according to their ability to deliver environmental gain per dollar of program expenditure. Applications can be accepted in rank order until the budget is exhausted or acreage cap is reached. This approach is used in EQIP, where contracts can be as short as one year (and as long as 10 years). In programs with long term contracts, however, program managers may take a more cautious approach. In CRP, for example, contracts are for a minimum of 10 years. To help decide which contract offers to accept, CRP program managers estimate the distribution of index scores among producers who may apply for CRP enrollment at a later date. Program managers may decide to reject some current applicants (even if they could be accommodated under the acreage cap) in the hope that producers who can deliver greater benefits per dollar of cost will apply in the future.

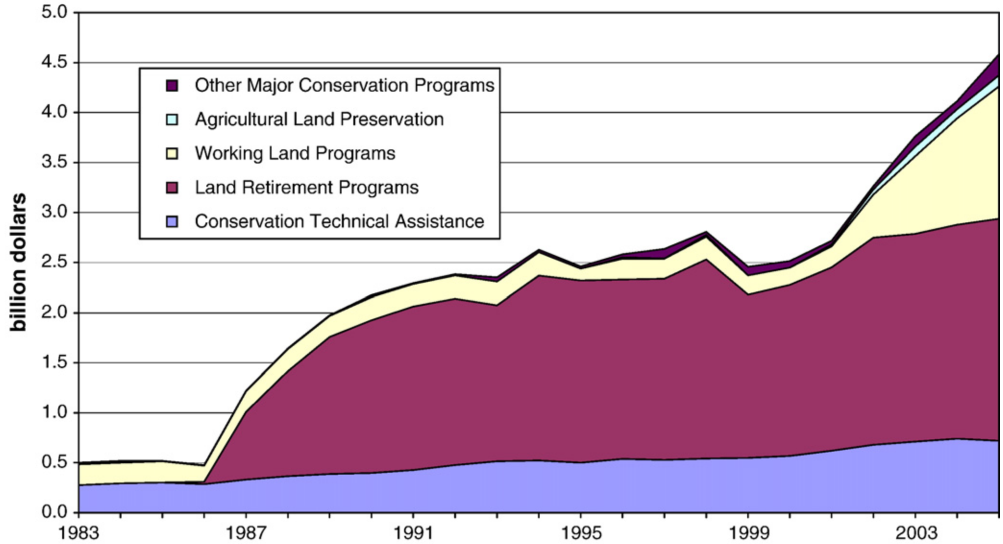
Of course, not all the information needed for effective benefit–cost targeting can be obtained from producers or existing data. The difficulty of linking on-farm actions to environmental outcomes is a key impediment to the development of cost-effective agri-environmental programs. For example, there is substantial evidence to suggest that nutrient and sediment runoff from farms has resulted in diminished water quality.[6] It can be very difficult, however, to trace nutrient and sediment back to specific farms where specific changes in land use or management could reduce runoff. Monitoring sediment and nutrient runoff from farmers can also be very expensive.[7] Physical process models can be used to estimate the origin of sediment or nutrient loads but they, too, can be data intensive and difficult to use.[8] Moreover, the relationship between pollutant loads and water quality may not be straightforward; in some cases environmental improvements may only be observed after substantial reductions in pollutant loads from many farms. Such threshold effects, where or when they occur, can have significant implications for program design (Wu and Boggess, 1999).

Even when farming practices can be definitively linked to water quality, the value of water quality improvements are difficult to measure. The value of environmental goods, such as water quality, that are generally not bought and sold in markets, must be measured through indirect means. For example, researchers may measure the costs that individuals incur to travel to water recreation sites. If individuals by-pass nearby locations in favor of locations with better water quality that are also more expensive to get to, the difference in travel cost can be an indication of willingness to pay for water quality. This type of valuation study (and other non-market

[6] Consider the example of Cottonwood Creek, ID (EPA, 2006a), where runoff from agricultural lands contributes to approximately 77% of the fecal coliform load impairment.

[7] See for example, summaries of monitoring costs for the EPA's section 319 National Monitoring Project (EPA, 2005).

[8] See for example, the TMDL Modeling Toolbox (EPA, 2006b), which illustrates the data design and use complexities.



Source: USDA Economic Research Service, based on data from USDA Office of Budget and Policy Analysis

Fig. 2 – Major USDA conservation expenditures 1983–2005.

methods) requires extensive survey data that is expensive to collect.

4. Implementation of U.S. agri-environmental programs: The case of CRP and EQIP

As already noted, land retirement has often dominated U.S. agri-environmental policy. Between 1985 and 2002, land retirement accounted for a large majority of USDA conservation-related payments to farmers (Fig. 2). In recent years, however, funding for working-land programs, like EQIP, has increased significantly relative to land retirement. CRP and EQIP are the largest U.S. agri-environmental programs, with funding of roughly $2.8 billion in 2005 — $1.8 billion for CRP and $1 billion for EQIP. A summary of key CRP and EQIP provisions can be found in Table 1.

The *Conservation Reserve Program* (CRP) offers 10–15 year contracts for retirement of land from crop production. In exchange, producers can receive cost-sharing for establishment of cover (usually grass or trees) and an annual payment determined by producer bids. Bids are subject to a field-specific cap designed to approximate the opportunity cost of foregone production and maintenance costs. Cost share payments are made only after cover is established. Land is eligible for CRP enrollment if it (1) has a history of crop production[9] and (2) is highly erodible,[10] is located in a national or state Conservation Priority Area, or will be devoted to wetland restoration, streamside buffers, or conservation buffers. Land under expiring CRP contracts is eligible for re-enrollment, but re-enrollment is not automatic; the producer must re-apply and be accepted again. Although eligibility is focused on highly erodible land, most CRP land is selected from producer offers using the Environmental Benefits Index (EBI), a benefit–cost index that accounts for a broad range of environmental concerns and the cost of the contract to the government (more details below; also see USDA-FSA, 1999, 2003).

At present, CRP enrollment is limited to 39.2 million acres (15.9 million hectares). At the end of 2005, 35.9 million acres (14.5 million hectares) were enrolled. More than 90% of CRP land and more that 80% of CRP payments are based on whole fields enrolled though the "general" sign-up.[11] During designated sign-up periods, producers with eligible land may offer bids that specify the land being offered, land cover that would be established (e.g., grass or trees), and the level of financial assistance they would be willing to accept. Offers are ranked using the EBI — bids with EBI scores above a cutoff level (selected for each sign-up period *after* bids are received) are accepted. Because it accounts for a large majority of CRP land and CRP expenditures, our subsequent discussion of CRP will focus on the general sign-up.

[9] A relatively small acreage of marginal pasture land enrolled as conservation buffers is also eligible.

[10] Highly erodible land has an erodibility index of 8 or greater. The erodibility index is the ratio of the soil inherent potential to erode – the estimated rate of erosion if the soil was continuously clean-tilled – to the soil T-factor, a measure of the soil's ability to withstand productivity damage from erosion.

[11] Land can also enrolled through "continuous sign-up" provisions, including the Conservation Reserve Enhancement Program (CREP). Producers can offer contracts for continuous sign-up enrollment at any time, without competition, but must meet more stringent guidelines regarding eligibility and cover or practice establishment. CREP is a state-federal partnership that focuses on small areas (individual watersheds) and offers higher payments and non-competitive enrollment as a means to concentrate on addressing a specific environmental issue, e.g., water quality along a specific segment of a river. Just over 2% of CRP acreage is in CREP. In addition to CREP, producers are offered non-competitive enrollment and higher payments for acreage devoted to high-priority practices such as riparian buffers, edge of field filter strips, grassed waterways and other "buffer" practices. These practices, when appropriate, can substantial improve water quality while taking only a small acreage out of production. High priority practices make up about 9% of CRP land. Despite their small acreage, however, CREP and continuous sign-up now account for 40% of all CRP contracts.

Table 1 – Provisions of the conservation reserve and environmental quality incentive programs

	CRP (general signup)	EQIP
Program type	Land retirement	Working land conservation
Budget	$1850 million in fiscal year 2004	$903 million in fiscal year 2004
Eligibility	Land cropped 4 of 6 previous years that is also highly erodible land or located in conservation priority areas. Land already enrolled in CRP is eligible for re-enrollment when the contract expires.	All types of agricultural production and agricultural land are eligible. All (250) practices in USDA (NRCS) conservation practice handbook can be funded. Sixty percent of funds are targeted to livestock-related resource concerns.
Participation incentives	Payments based on land retirement [a] 1986–1990: Payments fixed over multi-county areas. 1991–present: Producers submit bids subject to maximum bid based on local cash rental rates and productivity relative to other local soils.	Payments based on practice adoption [a] 1997–2001: Payment rates based on bids. For structural practices, producers bid on percent cost-share. For management practices, producer bid on percent of maximum incentive payment rate (which can vary by county). Incentive payments are available for up to 3 years to assist producers in transitioning to new production practices. 2002–present: Cost-share rate generally fixed at 50%. States can request exceptions for high benefit practices. Incentive payment rates also fixed by county.
Enrollment screening	1986–1990: None 1991–present; Environmental Benefits Index (EBI) is used to rank offers for acceptance. EBI includes multiple environmental indicators and a cost factor	Funds allocated to states using formula. Each state has "offer index" for ranking producer offers. Indices based on environmental benefits and costs (1997–2001). Assisting livestock operations with regulatory compliance is also important since 2002.

Source: Economic Research Service, USDA.
[a] Payments are not based on actual environmental performance (e.g., nutrient runoff) because performance (1) can not be monitored at a reasonable cost and (2) depends on weather and other factors outside producers' control (Braden and Segerson, 1993; Shortle and Dunn, 1986). In some cases, however, environmental performance can be modeled or proxy variables can be used to develop relative measures of potential environmental gain. In most U.S. programs, these tools are used in the context of determining which contracts to accept rather than how much to pay. So, even though payments are formally practice-based, programs can be benefit–cost targeted.

CRP was initiated in 1985, as part of a new soil conservation strategy based on highly erodible land (HEL). Information from the 1977 National Resources Inventory (NRI) showed that soil erosion was concentrated on a relatively small acreage of land with high natural propensity to erode (Berg and Grey, 1984). With eligibility focused largely on highly erodible land, the CRP was the first U.S. land retirement program to base eligibility on resource conditions or potential environmental damage (Heimlich and Claassen, 1998). Highly erodible land was, however, defined broadly enough to include traditional clients of farm support programs (Heimlich and Bills, 1986).

In its early years (1986–1990), the CRP enrollment focused on quickly enrolling large acreages rather than maximizing erosion reduction or minimizing cost per ton of erosion reduction (Reichelderfer and Boggess, 1988). Producers could retire land at a fixed price, set uniformly across multi-county areas, encouraging them to enroll relatively low productivity land. Landowners often received annual payments well in excess of market rates for annual rental, leading to an increase in the value of some CRP-eligible land (Shoemaker, 1989). In the late 1980s, research also showed that targeting water quality and wildlife habitat benefits could increase CRP benefits (Ribaudo, 1986; Ribaudo et al., 1990).

In 1990, major farm legislation broadened U.S. agri-environmental objectives and, for the first time, authorized environmental benefit–cost targeting. Since then, water quality and wildlife habitat have been major agri-environmental policy objectives, along with reducing soil erosion to preserve soil productivity. This broader set of environmental objectives, as well as cost, was (and is) reflected in the EBI, first developed and used in the early 1990s (Table 2).

Beginning in the early 1990s, USDA also ended the practice of accepting all bids that were at or under a pre-specified bid limit. Since then, only a portion of proposed CRP contracts have been accepted in any given sign-up, encouraging producers to bid against each other for CRP contracts. Producers could improve their overall EBI score – and their chance of being accepting into the program – by offering to take lower annual payments, forego cost-sharing on cover establishment, or establishing cover that is more effective as wildlife habitat (and more costly to establish). Field-specific bid limits, based on local cash rental rates for cropland and the productivity of soils in the specific field were also developed to deter unacceptably high bids.

The *Environmental Quality Incentives Program* (EQIP) was created in 1996 through consolidation of a number of programs. EQIP provides cost-sharing and incentive payments to producers who adopt environmentally friendly practices on working lands. Between 1996 and 2002, EQIP received funding between $150 million and $200 million per year (CRP received $1.5 billion or more in each of those years).

EQIP eligibility is broad: Both cropland and grazing land are eligible for EQIP as are many types of waste handling equipment and facilities used in livestock operations. In all,

Table 2 – Factors generating points for the conservation reserve program's environmental benefit index

EBI factors	Definition	Features that increase points	Maximum points
Wildlife	Evaluates the expected wildlife benefits of the offer.	·Diversity of grass/legumes ·Use of native grasses ·Tree planting ·Wetlands restoration ·Beneficial to threatened/endangered species ·Complements wetland habitat	100
Water quality	Evaluates the potential surface and ground water impacts	·Located in ground-or surface-water protection area ·Potential for percolation of chemicals and the local population using groundwater ·Potential for runoff to reach surface water and the county population	100
Erosion	Evaluates soil erodibility	·Larger field-average erodibility index	100
Enduring benefits	Evaluates the likelihood for practice to remain	·Tree cover ·Wetland restoration	50
Air quality	Evaluates gains from reduced dust	·Potential for dust to affect people ·Soil vulnerability to wind erosion ·Carbon sequestration	45
Cost	Evaluates cost of parcel	·Lower CRP rent ·No government cost share ·Payment is below program's maximum acceptable for area and soil type	Varies

This table includes the most common and highest scoring practices. For more information, see USDA-FSA, 2003.

about 250 different practices could be eligible for EQIP funding. For structural practices, such as grassed waterways or manure handling facilities, EQIP provides cost-sharing for initial installation. Payments are made when practices have been completed and approved. For management practices, such as conservation tillage or nutrient management, producers can receive annual incentive payments over a three year period to smooth the transition to new production methods.

In 2002, Congress dramatically increased funding for EQIP, reaching $1 billion in 2005, but also changed the program in ways that may affect environmental cost-effectiveness (Claassen, 2003; Cattaneo et al., 2005). Between 1996 and 2002, producers submitted bids indicating what resource concerns (e.g., soil quality, water quality) they were willing to address, what practices they would use to address the resource concern(s), and what level of payment they would be willing to accept for taking these actions. Bids for financial assistance were formulated as a percentage of cost (up to 75%) for structural practices and as a percentage of a local (county) maximum rate for management practices. Beginning in 2002, bidding on financial assistance was eliminated in favor of a flat 50% rate of cost-sharing for structural practices and a (locally) fixed rate of payment for management practices.[12]

EQIP funds are allocated to states using an allocation formula that accounts for a range of indicators-agri-environmental and other (USDA-NRCS, 2003). Between 1996 and 2002, states' program managers were required by statute to "maximize environmental benefits per dollar of expenditure." Therefore, producers' contract offers, or bids, were ranked for acceptance using state-specific "offer indices," similar in spirit to the EBI, but calculated as the number of environmental points (calculation varied by state) divided by contract cost. States could establish their own offer indices (within limits) to spend EQIP funds allocated to their state. In 2002, Congress abandoned the statutory requirement to maximize environmental gain while eliminating bids for financial assistance. Although the offer indices were retained and cost could still be considered in ranking applications, role of cost was reduced (Cattaneo et al., 2005).

The 2002 act eliminated the use of priority areas to target EQIP funding. Between 1996 and 2002, at least 65% of EQIP funds were expended within conservation priority areas (Cattaneo et al., 2005). Nearly 41% of all applications within priority areas were accepted while only 24% of applicants outside priority areas were enrolled. The 2002 legislation also increased emphasis on assisting producers with regulatory compliance (Claassen, 2003; Cattaneo et al., 2005). Eligibility and payment limitations were altered to include large confined animal feeding operations (CAFOs with more than 1000 animal units) which were first regulated under the Clean Water Act beginning in 2003 (Johansson and Kaplan, 2004). The portion of EQIP funds slated for livestock-related resource concerns increased from 50 to 60%. In 2003, livestock related concerns received 67% of EQIP payments.

5. Analysis of U.S. programs: How cost-effective are they?

Because cost-effectiveness is complex and difficult to achieve, economic analysis of cost-effectiveness can also be quite

[12] For some high priority practices, higher rates of cost-sharing have been allowed in states that request higher rates. By law, cost-share rates can be as high as 75%.

difficult. While the CRP has been the subject of much research, research on EQIP is limited. Nonetheless, simulation analysis and program data can help shed light on key questions related to EQIP. In the following sections, we address five over-arching questions regarding cost-effectiveness:

- Has benefit–cost targeting increased environmental gains per dollar of program expenditure? Could targeting be improved?
- Has bidding reduced program cost? Are bids likely to reveal producers' WTA?
- Is monitoring adequate to ensure contracted actions are, in fact, being implemented?
- Have programs resulted in environmental gains that would not have otherwise been obtained?
- How have CRP and EQIP affected producer welfare, especially limited resource (low income) producers?

6. Benefit–cost targeting: CRP

Early research on targeting showed significant potential for gain through benefit–cost targeting in the CRP (Reichelderfer and Boggess, 1988; Ribaudo et al., 1990). Babcock et al. (1996) describe several approaches to targeting and show that the environmental cost-effectiveness of each depends on the nature of heterogeneity among parcels offered for retirement. For example, least cost enrollment will maximize benefits relative to cost only when environmental benefits are negatively correlated with cost or the variation in benefits among parcels is very small compared to variation in cost. Their empirical analysis shows that benefit–cost targeting, as opposed to least-cost contracting, can increase environmental gain in terms of soil erosion due to water and water quality, but that gains from benefit–cost targeting are much smaller for wildlife and soil erosion due to wind.

Benefit–cost targeting, as implemented through the EBI, shifted emphasis from enrollment of low-cost land that was also highly erodible, to obtaining a wider range of environmental gains while considering cost. Although, the structure of the EBI has changed slightly over time, EBI points have been assigned based on 4–6 categories of environmental benefits and a cost factor (Table 2). Three major environmental factors – wildlife habitat, water quality, and soil erodibility (the potential for soil productivity damage) – each receive 100 of a total of about 400 possible environmental points. Although the number of points given the cost factor can vary between sign-ups, 150 points has been the norm in recent sign-ups. For any factor, any number of points between zero and the maximum can be assigned to a specific bid. For example, water quality points are assigned on the basis of location relative to ground or surface water resources deemed in need of protection.

Assuming the EBI effectively measures the attributes it is designed to represent (i.e., the water quality score reflects the likely value of water quality improvement), use of the index has broadened the focus of the CRP — contracts now reflect a portfolio of potential environmental benefits. On average, 20% of EBI points in contracts enrolled between 1997 and 2003 were based on wildlife habitat, 16% were based on water quality, 19% on soil erodibility (productivity), 35% on cost, and about 10% on other objectives. A single environmental factor only rarely accounts for more than 40% of points in an individual contract (Fig. 3). Cost points account for more than 40% of points in about 25% of contracts, but the cost factor has typically been assigned 150 points whereas the other three major EBI factors have been assigned 100 points each.

Although benefit–cost indices are only approximations of actual environmental benefits, research has shown that the EBI did increase the environmental benefits of the CRP. Feather et al. (1999) argue that the shift to environmental targeting increased annual environmental benefits from $464 million to $834.2 million—a gain of $370 million (25% of program cost)—while leaving costs unchanged (also see Feather and Hellerstein, 1997).[13] Benefit changes measured in the study included:

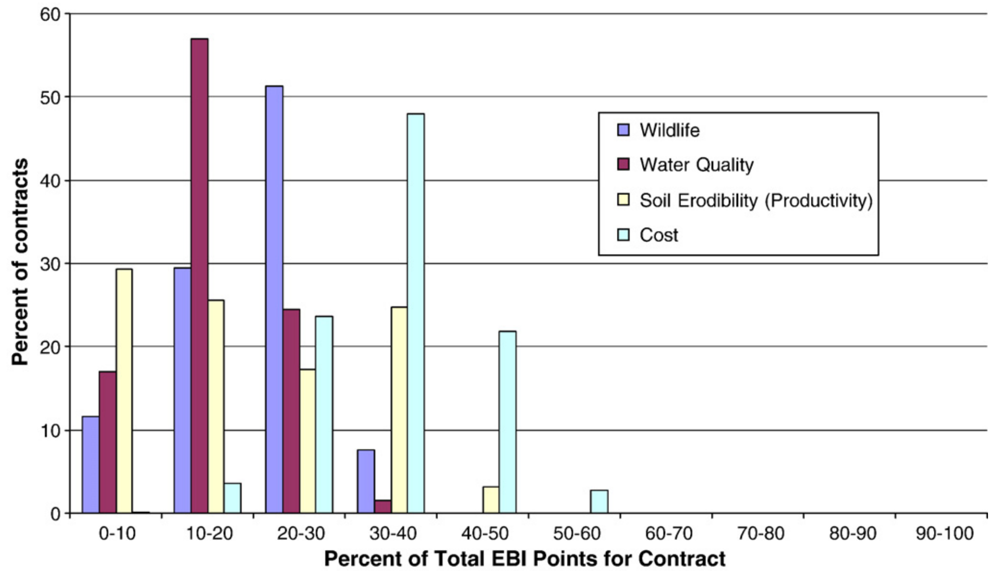
- Total freshwater-based recreation benefits attributable to the CRP increased by $92 million (a 255% gain);
- Benefits due to increased opportunities for wildlife viewing increased by $287 million (83%); and,
- Pheasant hunting benefits declined by $10 million (13%).

These changes were not distributed evenly across the landscape, as benefit increases were achieved, in part, by shifting CRP enrollment toward areas where greater benefits are available. These choices, however, did involve some trade-off as the decline in pheasant hunting benefits is due to a shift in CRP acreage away from regions where benefits due to pheasant hunting are relatively high.

While annual environmental benefits measured in Feather et al. (1999) fell short of the 1999 CRP budget, not all potential benefits were measured. A more complete accounting of annual CRP benefits shows environmental benefits of $1.12 billion (Sullivan et al., 2004). Even this figure is only a partial accounting, omitting many potential benefits such as groundwater quality, carbon sequestration, and waterfowl, small game, and large game hunting.

Nonetheless, research does suggest that additional improvements in environmental cost-effectiveness of the CRP could be achieved by further shifting emphasis from soil productivity maintenance to enhancing water quality and wildlife habitat. At present, the EBI by law places equal weight on water quality, wildlife habitat, and the soil erodibility factors. Because the erodibility index depends on the propensity of a soil to erode and on the likelihood that soil productivity will be damaged by erosion, it can be viewed as a proxy for potential losses in soil productivity. Although soil erosion can pollute water and air, the EBI soil erodibility factor does not account for proximity to water or downwind population. It is estimated that the benefits of improving water quality and wildlife habitat (even the partial estimates that are currently available) substantially exceed the benefits

[13] The baseline in this study was likely CRP enrollment without EBI. No attempt was made to estimate a "no CRP" baseline. Thus, overall benefit estimates do not account for the fact that some land that was enrolled in CRP might have been converted from crop production to grass or trees without CRP. See "Additionality and retention" for more discussion.



Source: Economic Research Service analysis of CRP contract data.

Fig. 3 – Share of EBI points, by major EBI factors.

of maintaining soil productivity (e.g., Ribaudo, 1986; Ribaudo et al., 1990; Feather et al., 1999). This result is particularly important given that private markets already induce farmers and landowners to protect soil productivity. As productivity declines, crop yields and returns will also decline, reducing land value. Thus, landowners have a market incentive to maintain productivity, particularly if productivity begins to decline in the short term.

7. Benefit–cost targeting: EQIP

Unlike CRP, benefit–cost targeting in EQIP has not been explicitly studied. Because the benefit–cost indices used to select contract offers for EQIP participation have been devised at the state and local level, environmental objectives vary by location. Thus, national or regional scale analysis of benefit–cost targeting in EQIP is extremely difficult to do. Nonetheless, program data suggests a large concern for water quality and water conservation. At a national level, water quality and conservation activities accounted for 34% of EQIP expenditures between 1997 and 2002, management of nutrients in livestock operations (which has water quality implications), accounted for 28% of expenditures, and conservation of soil and land accounted for 20% of expenditures. Only 6% of expenditures were for wildlife habitat-related activities and 12% went for other practices (USDA-ERS, 2006).

Despite the difficulty of evaluating EQIP, some insight on the potential for environmental gain from targeting can be realized through simulation modeling experiments. Cattaneo et al. (2005) provide some relevant results. Using an EBI-style index to measure environmental performance, they estimated that environmental performance-based (targeted) payments would generate twice as many index points as would a program of practice-based (non-targeted) payments, given $1 billion in program payments. With performance-based payments, moreover, some producers receive payments that exceed their cost. If the government, through an auction mechanism, can induce producers to reduce their bids, environmental gain per dollar of program expenditure could be further increased. Using conservation cost as a lower bound on bids, Cattaneo et al. (2005) note that the level of environmental gain could be increased by up to 25%. This maximum gain, however, would be realized only if costs are a good proxy for producer WTA and bids do, in fact, mirror WTA.

8. Bidding for financial assistance: CRP

Bidding on financial assistance in agri-environmental programs can help stretch limited budgets by reducing the cost of individual contracts (Latacz-Lohmann and Van der Hamsvoot, 1997). In terms of cost-effectiveness, as defined in U.S. programs, an ideal auction would induce program applicants to reveal their WTA — the lowest payment they are actually willing to accept for meeting program requirements. The extent to which auctions can, in fact, meet this objective depends largely on the amount of information producers have about how the government will assess their bids.

In the Conservation Reserve Program (CRP), producers can bid in a number of ways. First, CRP applicants can offer to take annual rental payments that are below the maximum established for the field they offer for retirement. The maximum rates or “bid caps” are a function of county average cropland rental rates and the productivity of the soils found in the field being offered for enrollment. As the annual payment declines, the overall EBI score rises. Second, producers who pay the full cost of establishing ground cover (e.g., grass or trees), rather than accepting cost sharing, also receive additional EBI points. Third, the number of points awarded for the EBI wildlife factor largely depends on the type of cover established. If covers that are better for wildlife,

Table 3 – Discounts and EBI scores for general CRP signups 1997–2003

Signup	Acres[a]	Proportion of total acres offered	Proportion offered with discount	Average discount	Average Exogenous EBI with discount	Average Exogenous EBI without discount	Average Endogenous EBI with discount	Average Endogenous EBI without discount
Enrolled								
Early 1997	16.17	0.71	0.57	2.99	197	200	50	54
Late 1997	5.92	0.65	0.53	6.68	198	209	76	70
1998	4.99	0.73	0.36	4.89	184	194	88	87
1999	2.46	0.73	0.38	5.80	183	194	89	89
2003	2.00	0.49	0.31	7.16	231	230	57	63
Not enrolled								
Early 1997	6.49	0.29	0.70	5.01	153	155	23	26
Late 1997	3.19	0.35	0.48	6.38	167	171	39	42
1998	1.81	0.27	0.42	5.67	153	161	53	54
1999	0.89	0.27	0.41	6.31	149	159	60	57
2003	2.06	0.51	0.27	6.49	181	181	49	51

Source: ERS analysis of CRP contract offer data.
[a] One acre equals .4046 ha.

such as trees or mixed native grasses, are also more expensive to establish then cover selection could be an integral part of a producer's overall bid. Finally, producers can affect their EBI score by selecting tracts of land with inherent characteristics that yield higher EBI scores. For example, land with a higher erodibility index will receive more soil erodibility points.

Producers who attempt to maximize their expected return from CRP will improve their bid (e.g., offer to take lower payments or establish better cover) only if they believe that it will improve their chances of enrollment (see Latacz-Lohmann and Van der Hamsvoot, 1997). In other words, producers may be willing to give up a portion of CRP return (or accept higher establishment/maintenance costs) in order to increase the chance of contract acceptance. On the other hand, producers who are confident that their bids will be accepted need not improve their offer.

While applying for CRP participation, producers are told their EBI *environmental* scores before they finalize their bids. On one hand, information on environmental scores could help producers assess their chances of enrollment and, in some cases, deter them from improving their bids. On the other hand, producers are not always aware of the level of environmental gain they have to offer and are more likely to offer land with high environmental potential if they are given this information about the environmental gains being sought and the type of land or land cover that is most likely to produce them (Ribaudo, 2004). Producers cannot, however, precisely determine their overall EBI score because the weight given to cost is determined only after all bids have been received. Moreover, the EBI cutoff score, which determines which contracts are actually accepted, is selected only after all bids have been received.

In practice, uncertainty about the acceptable level of bids has been reduced by multiple, sequential sign-ups from which producers have derived information on likely weight for the cost factor and the overall EBI cut-off score (see Cason and Gangadharan, 2004, for discussion of issues relating to sequential sign-ups). In 5 general CRP sign-ups held between 1997 and 2003, 31.5 million acres (12.7 million hectares) were enrolled, using an EBI that changed only slightly over that period. Over these five sign-ups, the cost weight was 150 points while the overall EBI cutoff was roughly 200 points in the 15th signup and hovered just under 250 points for sign-ups 16, 18, 20, and 26.[14] In an econometric analysis of CRP bidding, Kirwin et al. (2005) estimate that reduction in these uncertainties between sign-up 15 (in early 1997) and sign-up 20 (in 1999) reduced the level of discount from the bid limit offered (or increased the premium over WTA demanded) by producers in CRP contract bids. They estimate that premiums above WTA make up between 10 and 40% of the annual payments to producers who enter CRP through sign up 20 (1999) and signup 26 (2003).

For land enrolled and land rejected in general CRP sign-ups between 1997 and 2003, we can define a producer's *exogenous* EBI score as the score that would result from (1) establishing minimal ground cover, (2) offering no discount from the site-specific maximum annual payment, and (3) accepting cost sharing for cover establishment. Conversely, the *endogenous* EBI score can be defined as the difference between overall EBI score and the exogenous EBI and represents points due to improved land cover, lower annual payments, or waiving the cost-share. Examining statistics on exogenous and endogenous EBI scores (Table 3) we find that:

- competition has not been particularly intense (65–75% of applicants were accepted in 4 of the 5 sign-ups and 50% in signup 26);
- discounts have not been offered on all land and the proportion of acres offered with discounts has declined

[14] CRP general sign-ups are not sequentially numbered.

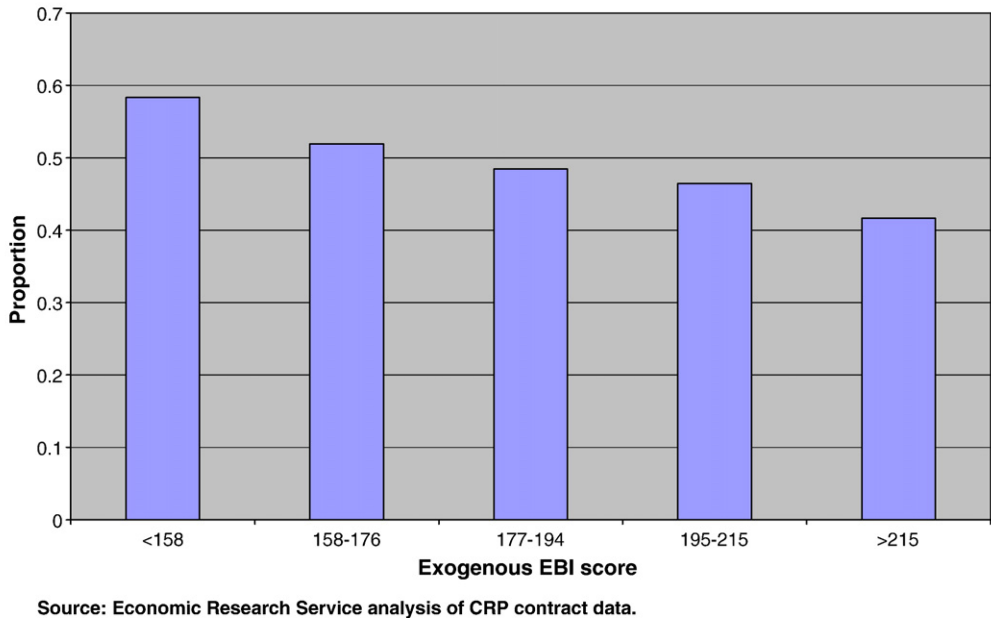


Fig. 4 – Proportion of acres offered with discount by exogenous EBI, for CRP general signups 15–26.

sharply over the 5 signups (although the average size of discounts, when offered, did not decline);

- producers who were accepted in CRP did not offer discounts more frequently or offer discounts that were larger than producers who were not enrolled;[15]
- exogenous EBI scores were significantly higher for producers who were enrolled in the program; and
- producers offering discounts tended to have lower exogenous EBI scores.

Graphically, we can see that producers with higher exogenous EBI scores are less likely to offer discounts, consistent with the previous discussion (Fig. 4).

9. Bidding for financial assistance: EQIP

Between 1997 and 2001, EQIP applicants were also asked to bid for financial assistance. During this period, bids were low relative to maximum rates and the number of applications declined each year. For structural practices (e.g., animal waste handling systems or grassed waterways) producers could bid up to 75% of cost but the average accepted bid was only 35%. For management practices (e.g., nutrient management, conservation tillage) producers could request up to 100% of the (county) maximum incentive payment rate for the practice, but the mean rate was only 43%.

A number of factors could explain low bids. First, broad eligibility and modest funding ($200 million/year or less before 2002) resulted in very competitive EQIP enrollment. In the first two years of the program, roughly 70% of program applicants were rejected. Second, the practices most often funded by EQIP (Table 4) suggest that many could produce private benefits, lowering WTA and allowing producers to bid below maximum rates. For example, waste storage facilities may be necessary for complying with local or state waste handling requirements; sprinkler irrigation systems that conserve water also reduce pumping costs; pasture planting can improve grass cover and reduce erosion but will also increase grazing productivity. Likewise, management practices that are most often funded, including conservation tillage, irrigation water management, prescribed grazing, and nutrient management can reduce production costs through careful management of production inputs. In fact, many producers have adopted these practices without incentive payments.

10. Monitoring and enforcement

The role of compliance monitoring in agri-environmental policy has received increasing attention from a theoretical perspective in recent years. Results include the relationship between monitoring costs and farmers' risk aversion in determining the optimal monitoring effort (Ozanne et al., 2001), the role of monitoring imperfections in leading to higher levels of incentive payments to ensure compliance (Choe and Fraser, 1998), and the importance of different farmer types (in terms of conservation costs) in contract design (Moxey et al., 1999). However, empirical analyses, due to data requirements, are still limited.

Recent reviews of monitoring and enforcement efforts in some U.S. agri-environmental programs have not been favorable. A recent U.S. Government Accountability Office (GAO) study identified serious deficiencies in the enforcement of U.S. cross-compliance requirements casting some doubt on the high (98%) rate of compliance estimated by USDA (U.S.

[15] That doesn't mean that cost is unimportant. A producer offering land valued at $30 per acre per year will receive a substantially higher cost score than a producer offering $100 per acre land. If environmental scores are equal, the producer with $100 land will be unable to compete with the $30 land.

Table 4 – Average bids for common EQIP practices, 1997–2001

Selected management practices	Average bid (% of maximum rate)
Conservation crop rotation	60
No-till/strip till	53
Mulch till	58
Cover crop	27
Residue management	26
Irrigation water management	39
Prescribed grazing	46
Nutrient management	48
Pest management	45
All management practices	43
Selected structural practices	**Average cost share rate (%)**
Waste storage facility	40
Fence	35
Sprinkler irrigation systems	42
Pasture/hay planting	45
Pipeline (livestock water)	18
Irrigation water pipeline	42
Brush management	29
Grade stabilization structure	39
Pond	38
All structural practices	35
All practices	36

Source: ERS analysis of EQIP contract data.

GAO, 2003). The USDA enforcement effort is based on visits to a small proportion of fields (about 5%) that are subject to compliance requirements, a process known as the Compliance Status Review (CSR). GAO criticized the CSR on the selection of the sample for review, a lack of consistency and clarity in the guidance provided to local offices, data handling and analysis, failure to cite producers for significant deficiencies, and inadequate justification for waivers and penalties.

In an analysis of U.S. Conservation Compliance, Giannakas and Kaplan (2005) suggest that the extent of producer non-compliance depends on the size of government payments linked to cross-compliance requirements, the costs associated with the adoption of conservation activities, by the resource costs of monitoring producer compliance, and by the available budget for enforcement activities. The authors report that the level of payment to be forgone in case of non-compliance has an important role in inducing compliance, whereas the audit probability (linked to enforcement costs and budget) has, in proportionate terms , a smaller role (lower elasticity), and conservation costs have an even lower impact.

In the context of an agri-environmental payment for working lands, Cattaneo (2003) finds that for EQIP, in a policy environment where enforcing contracts was viewed as costly, the government preferred not to pursue action against farmers who do not complete a conservation plan as specified.[16] This approach led to 17% of contract not being carried out in full. If increasing enforcement is not viable, the government can modify the incentives that led to withdrawing practices proposed voluntarily. Cattaneo's empirical results highlight how such program design parameters as the cost-share level, the length of contract, the size of contracts, the type of eligible conservation practices all have an impact on the incentives for a farmer to fully comply with an agri-environmental contract.

What the empirical results emphasize is that it is important to consider the difficulty of monitoring and enforcement when determining program design parameters such as practice eligibility, practice-specific payment rates, and the role of specific practices in contract acceptance criteria. The extent to which practice implementation and maintenance can be observed varies widely. Consider the potential tradeoff between nutrient management and conservation buffers in reducing nutrient runoff from cropland. Many nutrient management practices, including reduced application rates and better application timing, are difficult or impossible to monitor (Johansson, 2002). But nutrient runoff can also be intercepted before it leaves the field or enters a stream through filter strips, grassed waterways, or riparian buffers (Dosskey, 2001). The existence, adequacy of design, and maintenance of these buffer practices can be observed more easily than adherence to a nutrient management plan.

11. Transaction costs

Do the gains from bidding or benefit–cost targeting exceed the additional cost of implementing a more complex program? Transaction costs include the government's cost of formulating the program (e.g., establishing the EBI), the producer's cost of submitting an application and the government's cost of processing applications, selecting participants, entering into contracts, making payments, monitoring compliance, and taking enforcement actions when necessary. An indirect component of transaction cost is the data collection and research on which indices like the EBI are based.

For U.S. programs, funding for administration of agricultural programs, including conservation programs, is not generally reported at the level of detail that would be needed to determine the extra cost due to benefit–cost targeting or auctions. Nonetheless, we can obtain information on the potential size of certain components of transaction cost. First, USDA's Farm Service Agency, which implements the CRP, reported conservation-related salaries and expenses of $15.5 million in 2004, or less than 1% of the $1850 million CRP expenditure for that year. These expenditures can be modest, in part, because of the large databases on soil and land condition that already exist and can be harnessed to calculate EBI scored using GIS technology. For CRP applications, the location and proposed practices provided by the producer can be combined with spatially detailed data on soils, the likelihood of water quality damage, local populations, and other factors that go into EBI calculation.

Of course, the research and data behind the EBI are costly. A great deal of research and data was considered in creation of the EBI and ongoing research and data collection efforts may someday lead to significant improvement in the design of

[16] In most cases EQIP conservation practices can be easily monitored because payment occurs only upon proof of installation of a practice. For EQIP the enforcement cost of pursuing an observed violation deterred the government from taking punitive action.

environmental indices. In 2004, the estimated cost of USDA conservation-related research and data collection was about $530 million. These data collection and research efforts are, however, wide-ranging and extensive. What portion of that expense could be reasonably assigned to CRP, or any other U.S. agri-environmental program, is unknown.

12. Additionality and retention

Agri-environmental programs produce environmental gain only when the practices funded would not be adopted without the incentive provided by the program (Smith and Weinberg, 2004). Environmental gains based on actions that improve environmental performance, but would have taken place in the absence of program incentives (or requirements), do not represent additional gain. In practice, however, U.S. programs generally attempt to fund actions that were not being taken prior to the offer of a program incentive. For example, EQIP funds only those practices that have not previously been adopted by a particular producer. For structural practices (e.g., grassed waterways, riparian buffers), it is relatively easy to establish that a practice has not already been installed. For management practices (e.g., conservation tillage, nutrient management), however, it may be difficult or impossible to confirm that a practice is being adopted for the first time.

In CRP, producers who seek to place new land under CRP contract must show that it had a history of crop production before 2002. Producers who already have CRP contracts are eligible to re-enroll their CRP land, but must compete for contracts through the general sign-up process. Between 1986 and 1990 roughly 35 million acres (14.2 million hectares) were contracted under CRP, mostly in 10 year contracts. Beginning in 1996, producers with expiring contracts could apply for re-enrollment. At the end of 2001, roughly 55% of CRP acres were re-enrolled from previous contracts (Barbarika, 2001).

Whether gains are additional can be measured by comparing land use change or the adoption of conservation practices contracted under an agri-environmental program to a baseline which attempts to account for changes in land use and practice adoption that would have occurred in the absence of the program. Actually estimating a baseline can be difficult. While many practices funded through EQIP can produce significant private benefit (Hopkins and Johansson, 2004), it is not generally clear if private benefits will be sufficient to induce adoption in the absence of cost-sharing or incentive payments. Additional data and research on factors affecting the adoption of conservation practices would be needed to effectively estimate an EQIP baseline. For CRP, models of land use change, which include estimates of the effect of land retirement incentives, have been estimated. Lubowski et al. (2003) suggest that about 15% of the land enrolled in the CRP would have shifted to a non-crop land use in any case (note, however, that land used for grazing or timber production may not be as beneficial to wildlife as retired land). With respect to CRP re-enrollments, a key question is whether land would be returned to crop production if CRP contracts were not renewed. Additional benefits are obtained through contract renewal only to the extent that producers would have otherwise returned land to crop production. A recent estimate indicates that 51% of CRP land would be returned to crop production in the absence of CRP payments (Sullivan et al., 2004).

We note that environmental gains can also be undercut by the adverse, unintended consequences of environmental payment programs. For example, programs that increase the profitability of crop production relative to other land uses may induce shifts from forest or grazing use to crop production, which could increase environmental damage. The payment structures used in CRP and EQIP limit the potential for adverse consequences by attempting to limit payments to amounts that are at or near producer participation cost. CRP also requires that land be cropped in at least 4 of the 6 years prior to 2002 to prevent producers from changing land use for the purpose of gaining CRP eligibility. In general, U.S. policy discourages expansion of crop production on highly erodible land (HEL) or wetland through cross-compliance.

“Slippage” is another type of unintended consequence that may also be undercutting environmental gain in CRP and other programs. Slippage occurs when some producers expand cropland area, even as land is retired through CRP. That may occur as other producers expand crop production in anticipation of supply reduction and commodity price rises induced by land retirement. Wu (2000) estimates that 21 acres have been brought into production for every 100 acres retired in CRP. Other researchers have also estimated high CRP slippage rates (Leathers and Harrington, 2000). Roberts and Bucholtz (2005), using the same data as Wu, argue that CRP slippage rates are much smaller than found by Wu, suggesting some controversy around the magnitude of slippage in the CRP program.

13. Producer welfare and low income producers

Because CRP enrollment is equal to roughly 10% of U.S. cropland acreage, supply reductions due to CRP are likely to have had some impact on commodity prices and, indirectly, on producer welfare. Sullivan et al. (2004) estimate that only about half of CRP land would return to crop production if the CRP program were ended, but that increased production would have a measurable impact on crop prices. The largest effect was found for corn, where it is estimated production would rise by 4% and prices would decline by 6%. These results imply that maintaining land in CRP increases income for producers of crops that would otherwise be grown on CRP land. Other producers, who use these crops as inputs (e.g., livestock producers use corn and other feed grains) would benefit from lower grain prices if CRP were ended. Consumers may also benefit through lower food prices.

If CRP payments exceed what producers would otherwise be willing to accept for retiring land, there may also be a direct effect on producer welfare. As already noted, Kirwin et al. (2005) estimated that 10–40% of CRP payments are in excess of producer WTA (for CRP signups 20 and 26). In 2003, CRP payments were equal to just over 4% of overall net farm income. If CRP payments exceed WTA by 10%, producer gains could be on the order of one-half percent of farm income.

Existing data does not permit a similar analysis of EQIP. Because land remains in production, however, the impact of EQIP on production and prices is likely to negligible. Because

EQIP incentive payment and cost-share rates are higher than they were before 2002, on the other hand, EQIP may be increasing producer welfare directly. With larger budgets and larger enrollment, however, the program may also be attracting participants with higher costs of carrying out conservation activities who could not successfully compete for EQIP enrollment when competition was tighter and payment and cost-share rates were lower.

In terms of low income producers, EQIP can provide higher rates of payment and cost-share for limited resource producers (see footnote 5). CRP does not provide for higher payments to limited resource producers, but they are more likely to have land in the CRP when compared to the overall population of farms. CRP payments appear to be concentrated in the hands of retired farmers, individuals who live on farms but don't make farming their primary occupation, and limited resource (low income) farmers.[17] These producers account for about 60% of CRP payments but less than 9% of the value of agricultural sales. Limited resource farmers account for about 6% of CRP payments but only 1.5% of sales. It isn't entirely clear why these producers are more likely to enroll in CRP. They may be located on land that is more likely to earn a high EBI environmental score or they may be willing to offer their land for a relatively low annual payment. Producers who are retired, have other full time occupations, or operate from a base of limited resources may see CRP as a way to reduce farm labor requirements and/or reduce risk.

14. Conclusions

The U.S. uses a portfolio of payment programs and other policy instruments to encourage better environmental performance on U.S. farms. While much of the 70 year history of U.S. agri-environmental policy has been dominated by land retirement and by a concern for soil erosion and soil productivity, U.S. policy now focuses on a much broader array of environmental objectives and utilizes a more balanced portfolio of policy instruments. Beginning in 1985, non-payment policy instruments such as environmental cross-compliance came into use. Beginning in 1990, agri-environmental objectives were broadened to include wildlife habitat, water quality, and air quality in addition to traditional soil conservation concern. At that time, U.S. policymakers also embraced benefit–cost targeting and competitive bidding to increase the cost effectiveness of U.S. programs, particularly the CRP. In 2002, Congress redressed the balance between land retirement and conservation effort on working land by sharply increasing funding for working-land programs, primarily EQIP. These additional funds, however, were accompanied by changes that likely lowered EQIP cost effectiveness by reducing the emphasis on benefit–cost targeting, eliminating bidding for financial assistance, and focusing more resources on assisting producers with regulatory compliance.

Benefit–cost targeting procedures are well studied and appear to be effective, particularly those using an index such as the EBI. Simulation studies confirm that the potential for targeting to deliver larger benefit is also large in working land programs. However, even though targeting is important in the U.S. (because it is a very large, heterogeneous country) many aspects of targeting are controversial. Targeting techniques such as population weighting may be viewed as discriminatory by people in less densely populated areas. Others may wonder why their environmental problem (e.g., air quality) is viewed as less important than others' problems (e.g., water quality). This is particularly true when cheap reductions in soil erosion, etc., are bypassed for more expensive—but more valuable—reductions elsewhere.

Theory suggests bidding will improve program efficiency; however, existing program data from the CRP indicate that using similar auctions in repeated sign-ups has reduced the effectiveness of bidding in reducing program costs. Moreover, while bidding in a very competitive program could bring down the nominal costs of conservation, producers may end up bidding so close to their WTA that small changes in economic conditions may significantly alter their willingness to carry out the contracted practices. Further, the successful application of these tools depends critically on the availability of extensive databases on the quality of soils, topography, the location of land, local land rental conditions, etc., that can be readily accessed using GIS to quickly and inexpensively estimate benefit–costs indices and (when necessary) costs.

Finally, program design parameters, such as eligibility criteria, incentive levels, and targeting mechanisms (e.g., enrollment screening) also affect the extent to which potential gains in environmental performance are actually attained in practice. Additional research would be useful in the areas of transaction costs, the effectiveness of monitoring and enforcement, and questions related to additionality and permanence.

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